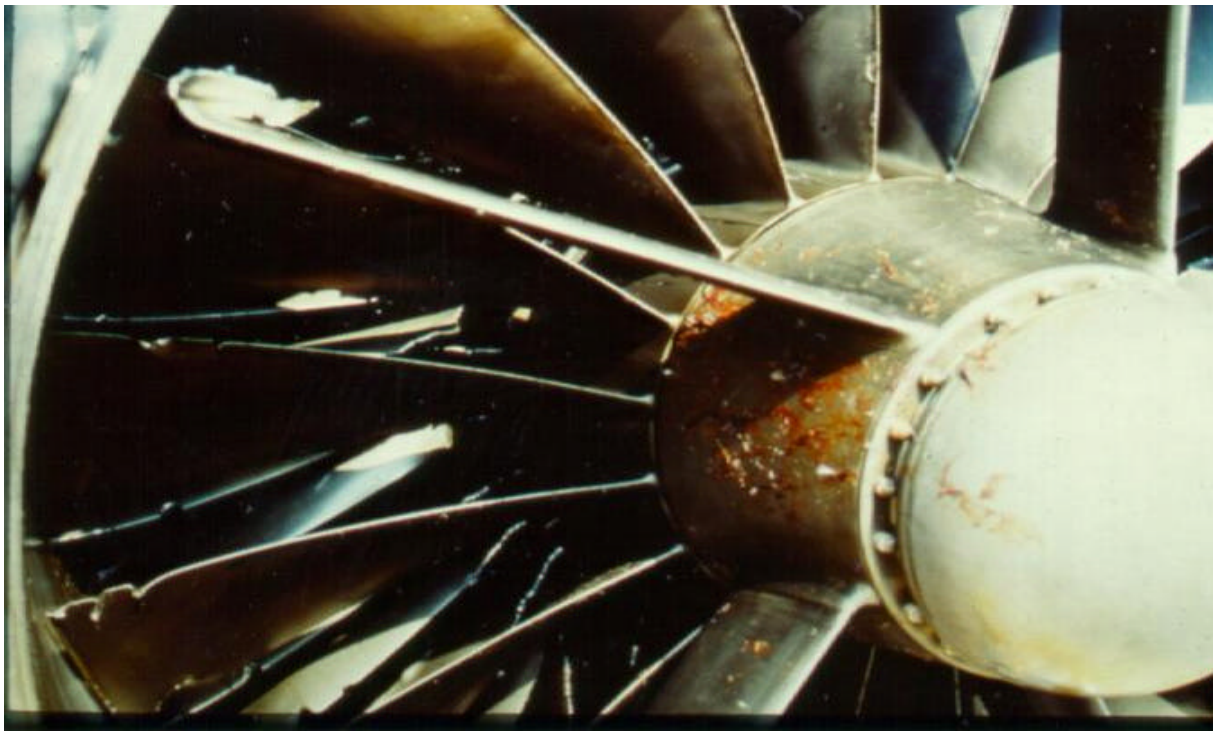
CHAPTER 2

THE FAA NATIONAL WILDLIFE STRIKE DATABASE FOR CIVIL AVIATION

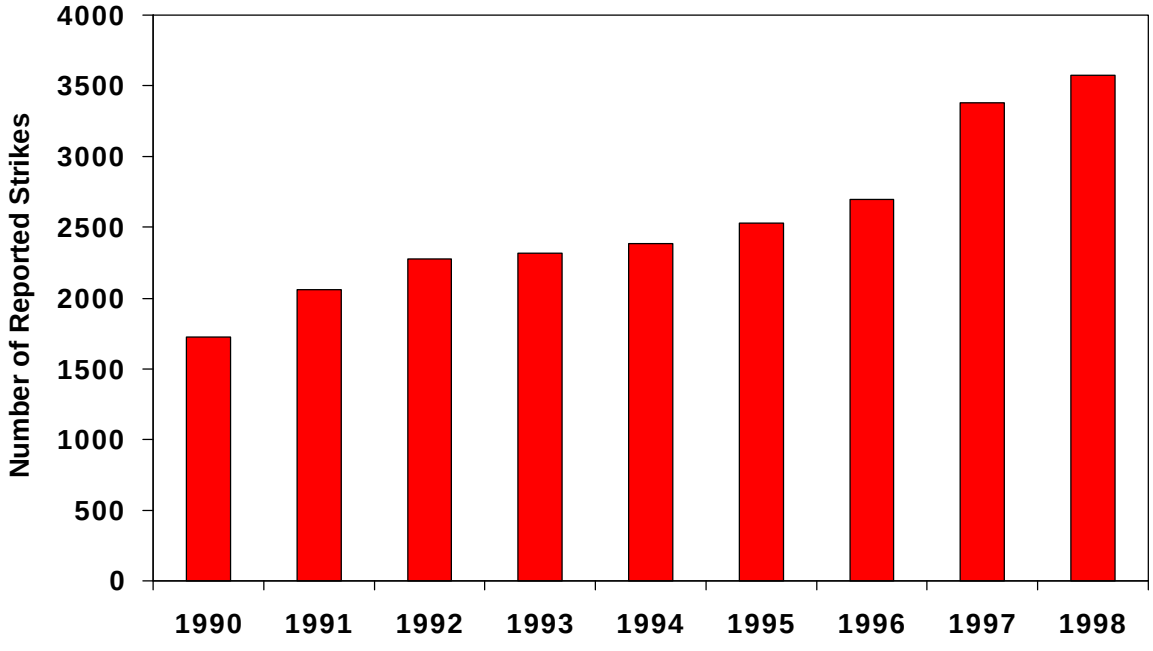


This engine from an Air France Concord jet ingested 1 or 2 Canada geese during landing at John F. Kennedy International Airport, 3 June 1995. The engine suffered an uncontained failure. (Photo by R. A. Dolbeer, USDA)

2.1 INTRODUCTION

Before a problem can be solved, the problem must first be understood. A necessary first step toward understanding the complex problem of aircraft collisions with wildlife is the collection and analysis of data from actual wildlife strike events. This chapter provides an overview of the structure and management of the Federal Aviation Administration (FAA) National Wildlife Strike Database for Civil Aviation. The chapter emphasizes the need for accurate reporting of wildlife strikes and the methods for reporting strike events. A statistical summary of reported wildlife strikes for civil aircraft, 1990-1998, is also presented to demonstrate the types of information obtained from the database. Finally, a list of selected individual strike cases provides an overview of the nature and magnitude of the wildlife strike problem in the United States.

Figure 2-1. Reported wildlife strikes to civil aircraft by year, USA, 1990-1998 (n = 22,935 total strikes).



2.2 REPORTING WILDLIFE STRIKES

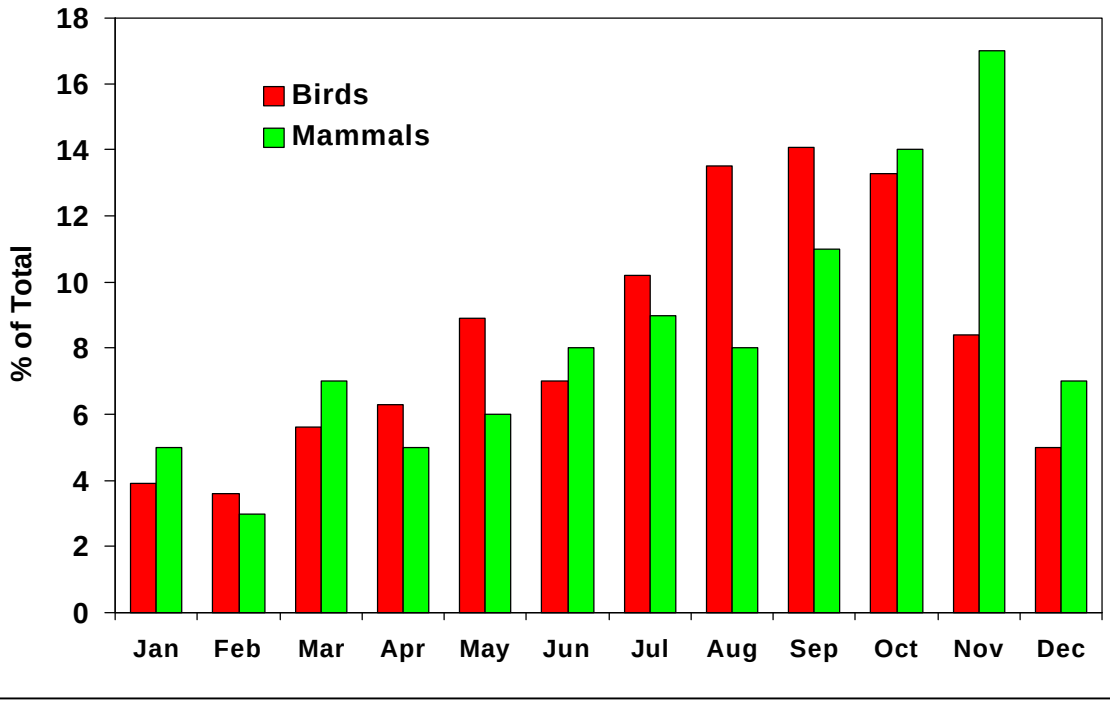
The FAA has a standard form (FAA Form 5200-7 - Bird/Other Wildlife Strike Report [see Appendix H]) for the voluntary reporting of bird and other wildlife strikes with aircraft. To improve the ease of reporting, strikes can also be reported via the Internet (http://www.faa.gov/arp/birdstrike).

Strikes should be reported by pilots, airport operations and aircraft maintenance personnel, or anyone else who has knowledge of the strike. It is important to include as much information as possible on FAA Form 5200-7. The identification of the species of wildlife struck is particularly important. Bird strike remains that can not be identified by airport personnel can often be identified by a local biologist or by sending feather remains in a sealed plastic bag (with FAA Form 5200-7) to:

Federal Aviation Administration
Office of Airport Safety and Standards, AAS-310
800 Independence Avenue, SW
Washington, DC 20591

Chapter 8 provides more details on strike reporting.

Figure 2-2. Reported bird and mammal strikes to civil aircraft by month, USA, 1990-1998 (% of total strikes, n = 22,320 birds; 580 mammals).



Analyses of wildlife strike data have proven invaluable in determining the magnitude and severity of the wildlife strike problem. The database provides a scientific basis for identifying risk factors, justifying, implementing and defending corrective actions at airports, and for judging the effectiveness of those corrective actions. The database is also of value to engine manufacturers and aeronautical engineers.

2.3 MANAGEMENT OF DATABASE

The FAA National Wildlife Strike Database is managed by the National Wildlife Research Center (NWRC) of the U.S. Department of Agriculture's Wildlife Services program under terms of an Interagency Agreement with FAA. All strike reports are sent to the NWRC for entry into the database after review by the staff Wildlife Biologist at FAA, Office of Airport Safety and Standards. At the NWRC, a database manager edits each strike report and consolidates multiple reports for the same strike before entering the data. Contacts with persons making reports are sometimes made for clarification of details. In addition to FAA Form 5200-7, strike reports are also obtained from other sources (Table 2-1). After entry into the database, the original reports are filed chronologically for future reference if necessary. There are approximately 23,000 strike records in the database for 1990-1998.

Table 2-1. Source of information for reported wildlife strikes to civil aircraft, USA, 1990-1998.

Source	Reported strikes (1990-1998)		
	9-year total	9-year avg.	% of total
FAA Form 5200-7	17,308	1,923	75
Other[a]	2,069	230	9
Multiple	1,920	213	8
Airport Report	1,354	150	6
Airline Report	284	32	1
Total	22,935	2,548	100

[a] Preliminary Aircraft Incident Report; Aviation Safety Reporting System, Aircraft Incident Preliminary Notice, National Transportation Safety Board.

Table 2-2. Person filing report of wildlife strike to civil aircraft, USA, 1990-1998.

Person reporting	Reported strikes (1990-1998)		
	9-year total	9-year avg.	% of total
Pilot	6,353	706	28
Tower	3,878	431	17
Unknown	7,455	828	33
Carcass found[a]	1,686	187	7
Airport operations	1,477	164	6
Airline operations	1,323	147	6
Other	763	85	3
Total	22,935	2,548	100

[a] Airport operations personnel found wildlife remains on runway that appeared to have been struck by aircraft and no strike was reported by pilot, tower or airline.

Table 2-3. Number of reported wildlife strikes to civil aircraft by type of operator, USA, 1990-1998.

Operator	Reported strikes (1990-1998)		
	9-year total	9-year avg.	% of total
Commercial	16,611	1,846	72
Business	2,814	313	12
Private	961	107	4
Government/police	88	10	<1
Unknown	2,461	273	11
Total	22,935	2,548	100

2.4 USE OF INFORMATION IN DATABASE

Maintaining a consistent record of wildlife strikes at an airport is essential for defining the wildlife hazard level and for evaluating the airport's Wildlife Hazard Management Plan as discussed in Chapter 8. In addition to their internal use at the airport, the strike reports, when incorporated into the National Wildlife Strike Database, provide a means

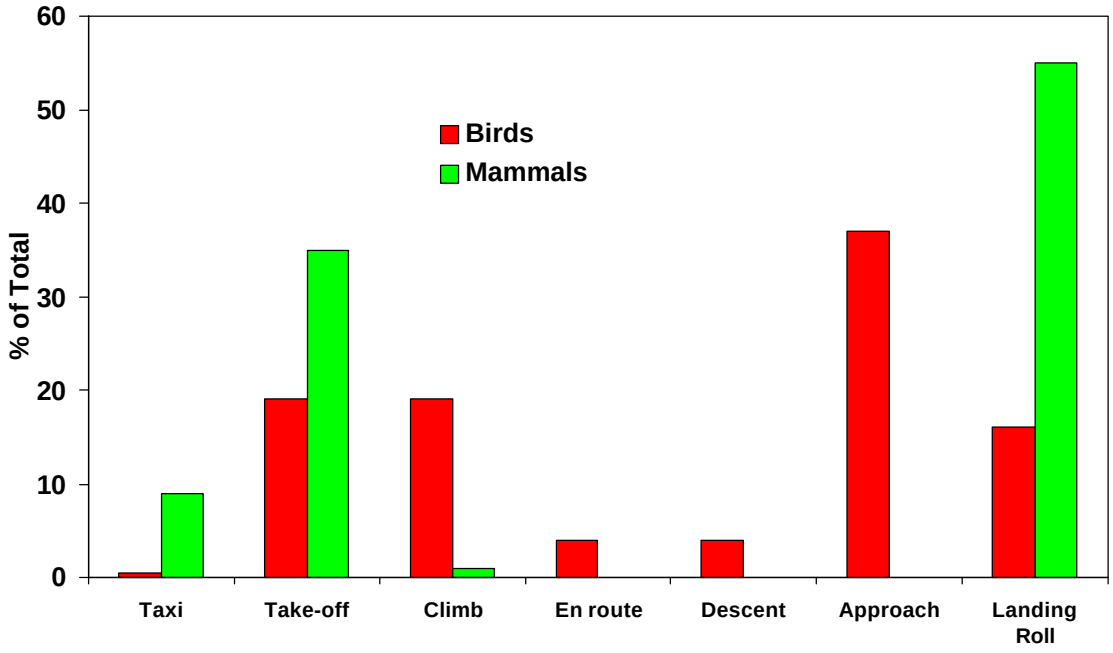
Table 2-4. Number of reported bird and mammal strikes to civil aircraft by U.S. state, including Puerto Rico (PR) and the U.S. Virgin Islands (VI), 1990-1998.

	Reported strikes (1990-1998)				Reported strikes (1990-1998)		
State	Birds	Mammals	Total	State	Birds	Mammals	Total
AK	215	5	220	ND	45	0	45
AL	282	4	286	NE	209	7	216
AR	125	11	126	NH	78	4	82
AZ	167	17	184	NJ	673	27	700
CA	2,017	20	2,037	NM	49	1	50
CO	261	7	268	NV	116	2	118
CT	317	13	330	NY	1,445	36	1,481
DC	571	18	589	OH	724	15	739
DE	14	1	15	OK	233	14	247
FL	2,056	29	2,085	OR	301	4	305
GA	454	9	463	PA	1,040	48	1,088
HI	474	1	476	PR	39	0	39
IA	172	3	175	RI	63	3	66
ID	51	4	55	SC	125	4	129
IL	1,235	43	1,238	SD	38	3	41
IN	232	5	237	TN	591	6	597
KS	66	2	68	TX	1,775	30	1,805
KY	603	4	607	UT	240	4	244
LA	531	6	537	VA	460	18	478
MA	326	7	333	VI	32	0	32
MD	268	16	284	VT	16	0	16
ME	100	4	104	WA	382	8	390
MI	409	26	435	WI	244	14	258
MN	206	6	212	WV	75	31	106
MO	400	13	413	WY	13	2	15
MS	100	3	103				
MT	36	1	37	USA total	21,257	574	21,831
NC	563	15	578	Foreign[a]	1,063	6	1,069
				Total	22,320	580	22,900

[a] Reported strikes to USA carriers at foreign airports.

for engineers, biologists, and safety analysts to better understand national and regional trends in strikes and thereby develop, justify and defend more effective management programs and wildlife-resistant aircraft and engines. For example, the database has been extremely useful in identifying which wildlife species are most commonly involved in strikes, the seasonal pattern of strikes for various species, the extent and types of damage resulting from strikes, and which aircraft types and components are most vulnerable. It is emphasized that the strike records in the national database are summarized statistically at the regional or national level for trends. Comparisons among individual airports and airlines are not made.

Figure 2-3. Reported phase of flight at time of bird and mammal strikes to civil aircraft, USA, 1990-1998 (% of total strikes in which phase of flight was reported, n = 19,728 for birds; n = 494 for mammals).



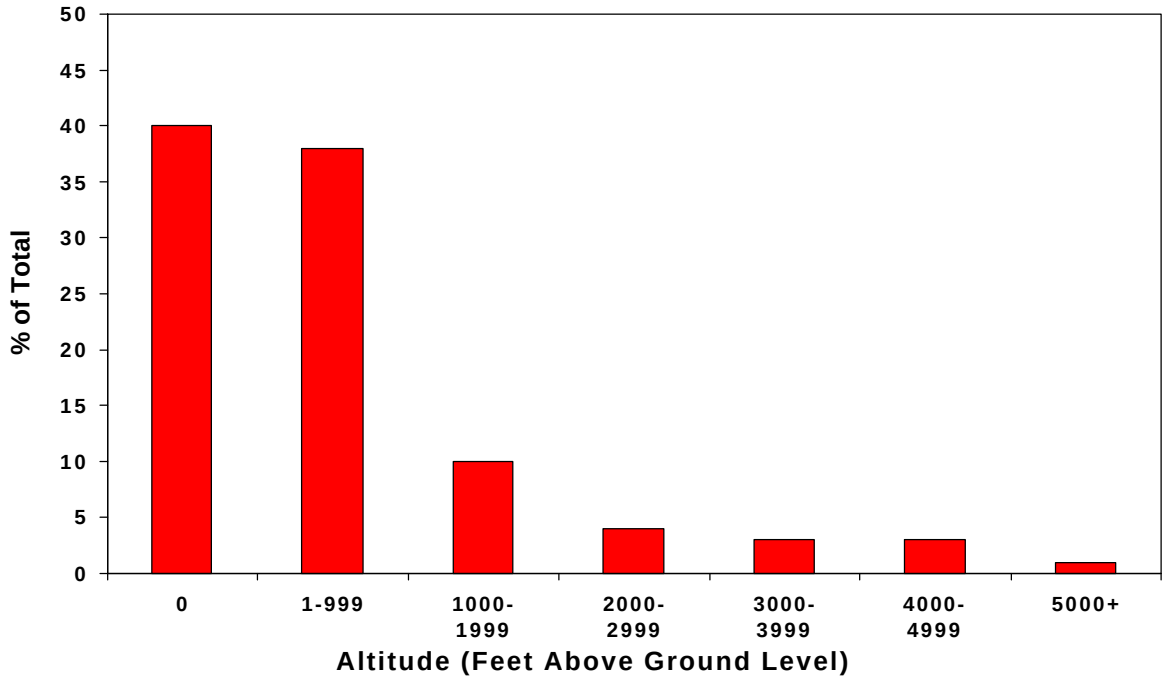
2.5 SUMMARY OF WILDLIFE STRIKE RECORDS, 1990-1998

The FAA's Office of Airport Safety and Standards publishes an annual report, *Wildlife Strikes to Civil Aircraft in the United States*. This report contains a detailed analysis of the most current strike data. Copies of the current annual report can be downloaded from the FAA's Wildlife Hazard Web page at: http://www.faa.gov/arp/hazard.htm.

The following section presents a summary analysis of reported wildlife strikes to civil aircraft in the USA for 1990-1998 to provide an overview of the types of information obtained from the database. Reports were received from all 50 states, some U.S.

territories, and from foreign countries when U.S. registered aircraft were involved in a strike. Because less than 20% of all strikes have been reported to the FAA and many reports received by the FAA were filed before aircraft damage was fully assessed, the number of strikes and associated cost data compiled from the voluntary reporting program greatly underestimate the magnitude of the problem.

Figure 2-4. Number of reported bird strikes to civil aircraft by altitude, USA, 1990-1998 (% of total strikes for which altitude was reported, n = 18,080).



2.5.a Strike Frequency

For the 9-year period, 22,935 strikes (average of 2,548/year) were reported to the FAA. From 1990 to 1998, there was a 107% increase in the number of strikes reported annually (Figure 2-1). Most reports (75%) were filed using FAA Form 5200-7 (Table 2-1). Pilots and tower personnel filed 28% and 17% of the reports, respectively (Table 2-2). About 72% of the reported strikes involved commercial aircraft; the remainder involved business, private, and miscellaneous aircraft (Table 2-3). Table 2-4 shows the distribution of reported bird and mammal strikes for the various states and territories. Florida, California and Texas had the most strike reports.

2.5.b Types of Wildlife Involved

Birds were involved in 97% of the reported strikes, mammals in 3%, and <1% involved reptiles. Gulls, raptors, blackbirds, waterfowl, and doves (including pigeons) were the most commonly struck bird groups (Table 2-5). The most commonly struck mammals were deer and coyotes (Table 2-6). Gulls were involved in 2.6 times as many strikes as waterfowl, but both groups were involved in about the same number of damaging strikes (Table 2-5).

2.5.c Characteristics of Strikes

Most bird strikes (50%) occurred between July and October (Figure 2-2); 66% occurred during the day (Table 2-7); 55% occurred when the aircraft was on approach or during the landing roll, and 39% occurred during takeoff and climb (Figure 2-3). About 40% of bird strikes occurred when the aircraft was at 0 feet above ground level (AGL), 78% occurred under 1,000 ft. AGL (Figure 2-4).

Table 2-5. Identified birds involved in reported wildlife strikes to civil aircraft, USA, 1990-1998.

Bird group	9-year total	% of total known	No. (%) of strikes causing damage
Gulls/terns	3,252	30	578 (18)
Raptors	1,366	13	307 (23)
Blackbirds/starlings	1,340	12	72 (5)
Waterfowl	1,243	12	578 (47)
Doves/pigeons	1241	11	134 (11)
Sparrows	788	7	17 (2)
Wading birds (herons, egrets)	474	3	62 (19)
Shorebirds (plovers, sandpipers)	334	3	40 (11)
Swallows/swifts	278	3	4 (1)
Miscellaneous perching birds	270	3	12 (4)
Corvids (crows, jays, etc.)	199	2	20 (10)
Gallinaceous birds (pheasants, etc.)	61	1	19 (31)
Miscellaneous birds	86	1	12 (14)
Total known	10,831	100	1,855 (17)
Total unknown	11,489[a]		
Total	22,230		

[a] There were 22,320 bird strikes reported; 11,489 (52%) provided no information on species of bird.

The greatest percentage of mammal strikes (31%) occurred during October-November (Figure 2-2); 61% occurred at night (Table 2-7); 60% occurred when the aircraft was on approach or landing; and 34% occurred during takeoff (Figure 2-3). About 12% of reported mammal strikes occurred while the aircraft was in the air, when aircraft struck deer with the landing gear or encountered bats (Figure 2-3).

Table 2-6. Identified mammal and reptile groups involved in reported wildlife strikes to civil aircraft, USA, 1990-1998.

Wildlife group	9-year total	% of total known	No. (%) of strikes causing damage
Mammals			
Deer & other ungulates	385	67	311 (81)
Coyotes & other carnivores	112	20	10 (9)
Bats	27	5	2 (7)
Rodents	18	3	0 (0)
Opossum	14	2	0 (0)
Armadillos	11	2	0 (0)
Rabbits/hares	6	1	0 (0)
Total known mammals	573	100	323 (56)
Total unknown mammals	7		
Total mammals	580		
Reptiles			
Turtles	25	71	0 (0)
Alligators	10	29	1 (10)
Total reptiles	35	100	1 (3)

Table 2-7. Reported time of occurrence of wildlife strikes to civil aircraft, USA, 1990-1998.

	Birds		Mammals	
Time	9-year total	% of total known	9-year total	% of total known
Dawn	824	4	10	2
Day	13,551	66	132	26
Dusk	1,017	5	52	10
Night	5,186	25	307	61
Total reported	20,578	100	501	100
Not reported	1,742		79	
Total	22,320		580	

2.5.d Aircraft Components Struck and Damaged

Aircraft components most commonly reported struck by birds were radome/nose, windshield, engine, and wing/rotor (Table 2-8). Those components most often reported

as damaged were engine, wing/rotor, radome/nose, and windshield. Aircraft components most commonly reported as struck by mammals were landing gear, propeller, wing/rotor, and engine (Table 2-8). These same components ranked highest for the parts most often reported as damaged. About 19% of strikes resulted in minor to substantial damage to the aircraft (Table 2-9).

Table 2-8. Civil aircraft components reported as being struck and damaged by birds and mammals, USA, 1990-1998.

	Birds (9-year total)		Mammals (9-year total)	
Part of Aircraft	Struck	Damaged	Struck	Damaged
Radome/nose	4,687	571	33	27
Windshield	3,539	308	7	4
Engine	3,201	1,357	51	49
Wing/rotor	2,544	873	63	65
Fuselage	2,107	136	35	33
Landing Gear	1,049	147	187	122
Propeller	722	86	82	72
Tail	298	145	21	24
Light	184	157	6	6
Other	610	298	55	55
Total	18,941	4,078	540	457

2.5.e Effects of Wildlife Strikes on Aircraft and Flights

For the 9-year period, 3,773 reports (19% of known total) indicated the strike damaged one or more aircraft components (Table 2-9), and 2,434 reports (15% of known total) indicated the strike had a negative effect on the flight (Table 2-10). Only 988 strike reports provided an estimate of the aircraft down time (total = 163,667 hours, average = 166 hours/incident), and 759 reports provided an estimate of the direct or other costs (total = $74,407,875, average = $139,650/incident). Of the 759 reports providing a damage cost estimate, 681 provided an estimate of direct aircraft damage (total = $61,877,083, average = $90,887/incident), and 262 provided an estimate of other monetary losses (total = $12,513,130, average = $47,764/incident).

Table 2-9. Reported damage resulting from wildlife strikes to civil aircraft, USA, 1990-1998.

Damage	9-year total	% of known total
None	16,283	81
Minor[a]	2,086	10
Unknown[b]	400	2
Substantial[c]	1,268	6
Destroyed[d]	19	<1
Total reported	20,056	100
Not reported	2,879	
Total	22,935	

[a] Aircraft can be rendered airworthy by simple repairs or replacements and an extensive inspection is not necessary.

[b] Aircraft was damaged, but details as to the extent of damage are lacking.

[c] Aircraft incurs damage or structural failure which adversely affects the structure strength, performance or flight characteristics and which would normally require major repair or replacement of the affected component. Specifically excluded are: bent fairings or cowlings; small dents or puncture holes in the skin; damage to wing tips, antenna, tires or brakes; engine blade damage not requiring blade replacement.

[d] Damaged sustained makes it inadvisable to restore aircraft to an airworthy condition.

Table 2-10. Reported effect-on-flight of wildlife strikes to civil aircraft, USA, 1990-1998.

	Birds		Mammals	
Effect-on-flight	Total	% of known total	Total	% of known total
None	13,290	86	135	37
Aborted takeoff	557	4	66	18
Precautionary landing	1,126	7	39	11
Engine shut down	128	1	8	2
Other	391	2	119	32
Total reported	15,492	100	367	100
Not reported	6,828		213	
Total	22,320		580	

Assuming all reported wildlife-aircraft strikes that had an adverse effect on the aircraft and/or flight produced similar amounts of down time and/or monetary losses, and that these reports are all of the damaging strikes that occurred, wildlife strikes cost the U.S. civil aviation industry a minimum of 92,233 hours/year of aircraft down time, $50.6 million/year in direct monetary losses, and $26.6 million/year in associated costs. Further, assuming a 20% reporting rate, the cost of wildlife-aircraft strikes to the U.S. civil aviation industry is estimated to be in excess of 461,165 hours/year of aircraft down

time, $253 million/year in direct monetary losses and $133 million/year in associated costs.

2.6 SELECTED EXAMPLES OF WILDLIFE STRIKES

Below is a description of some significant wildlife strikes that have influenced flight safety policy or are typical of damaging strikes in the USA.

- **3 April 1912**. Calbraith Rogers, the first person to fly across the continental United States, was also the first to die as a result of a bird strike. On April 3, 1912, Rogers' Wright Pusher struck a gull, causing the aircraft to crash into the surf at Long Beach, California. Rogers was pinned under the wreckage and drowned.

- **10 March 1960.** A Lockheed Electra turbo-prop ingested European starlings into all 4 engines during takeoff from Boston Logan Airport (MA). The plane crashed into Boston Harbor, killing 62 people. Following this accident, the FAA initiated action to develop minimum bird ingestion standards for turbine-powered engines.

- **26 February 1973.** On departure from Atlanta's Dekalb-Peachtree Airport (GA), a Learjet 24 struck a flock of brown-headed cowbirds attracted to a nearby trash transfer station. Engine failure resulted. The aircraft crashed, killing 8 people and seriously injuring 1 person on the ground. This incident prompted the FAA to develop guidelines concerning the location of solid waste disposal facilities on or near airports.

A DC-10 is engulfed in flames at John F. Kennedy International Airport in the aftermath of a strike with gulls in November 1975. (Photo courtesy Port Authority of New York and New Jersey)

- **12 November 1975.** On departure roll from John F. Kennedy International Airport (NY), the pilot of a DC-10 aborted takeoff after ingesting gulls into 1 engine. The plane ran off the runway and caught fire as a result of engine fire and overheated brakes. The resultant fire destroyed the aircraft. All 138 people on board were airline personnel who had received emergency evacuation training. They all evacuated safely. Following this accident, the National Transportation Safety Board recommended the FAA evaluate the effect of bird ingestion on large, high-bypass, turbofan engines and the adequacy of engine certification standards. The FAA initiated a nationwide data collection effort for documenting bird strike and engine ingestion events.

- **25 July 1978.** A Convair 580 departing Kalamazoo Airport (MI) ingested 1 American kestrel into an engine on takeoff. The engine autofeathered and aircraft crashed in nearby field, injuring 3 of 43 passengers.

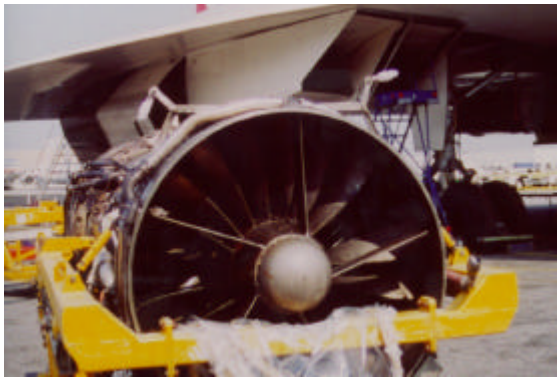
- **5 November 1990.** During takeoff at Michiana Regional Airport (IN), a BA-31 flew through a flock of mourning doves. Several birds were ingested in both engines and takeoff was aborted. Both engines were destroyed. Cost of repairs was $1 million and time out of service was 60 hours.

- **30 December 1991.** A Citation 550, taking off from Angelina County Airport (TX) struck a turkey vulture. The strike caused major damage to #1 engine and resulting shrapnel caused minor damage to the wing and fuselage. Cost of repairs was $550,000 and time out of service was 2 weeks.

- **2 February 1992.** A Piper Cherokee struck a deer at rotation during takeoff from Sandstone Municipal Airport (MN). The pilot attempted to turn back to airport but impacted into trees just south of airport. Aircraft was destroyed and pilot seriously injured.

- **3 December 1993.** A Cessna 550 struck a flock of geese during initial climb out of DuPage County Airport (IL). The pilot heard a loud bang and the aircraft yawed left and right. Instruments showed a loss of power to #2 engine and a substantial fuel leak on the left side. An emergency was declared and the aircraft landed at Midway Airport. Cost to repair 2 engines was $800,000 and time out of service was about 3 months.

- **21 October 1994.** A Cessna 210 struck a coyote during landing roll at Higginsville Industrial Municipal Airport (MO) at night. The nose gear collapsed, causing the propeller to hit runway, resulting in major damage to engine and crankshaft.



One engine from a Concorde showing damage from a goose strike in June 1995 at John F. Kennedy International Airport. (Photo by R. A. Dolbeer, USDA)

- **3 June 1995.** An Air France Concorde, at about 10 feet above ground level (AGL) while landing at John F. Kennedy International Airport (NY), ingested 1 or 2 Canada geese into the #3 engine. The engine suffered an uncontained failure. Shrapnel from the #3 engine destroyed the #4 engine and cut several hydraulic lines and control cables. The pilot was able to land the plane safely, but the runway was closed for several hours. Damage to the Concorde was estimated at over $7 million. The French Aviation Authority sued the Port Authority of New York and New Jersey and eventually settled out of court for $5.3 million.

This is all that remains of one engine from the ill-fated AWACS aircraft, September 1995. (Photo courtesy USAF)

- **22 September 1995.** A U.S. Air Force Airborne Warning and Control System (AWACS) aircraft (modified Boeing-707) crashed, killing all 24 on board, after ingesting 4 Canada geese into #1 and #2 engines during takeoff from Elmendorf Air Force Base (AK). This was the first crash of an AWACS plane since the Air Force began using them in 1977. This strike involving a military aircraft is not included in the FAA National Wildlife Strike Database. It is listed here because of the severity of the incident.

- **5 October 1996.** A Boeing-727 departing Washington Reagan National Airport (DC) struck a flock of gulls just after takeoff, ingesting at least 1 bird. One engine began to vibrate and was shut down. A burning smell entered the cockpit. An emergency was declared and the aircraft, carrying 52 passengers, landed at Washington National. Several engine blades were damaged.

- **7 January 1997.** A MD-80 aircraft struck over 400 blackbirds just after takeoff from Dallas-Fort Worth International Airport (TX). Almost every part of the plane was hit. The pilot declared an emergency and returned to land without event. Substantial damage was found on various parts of the aircraft and the #1 engine had to be replaced. The runway was closed for an hour. About 100,000 blackbirds were roosting in the terminal area and were feeding on cereal grain crops on and in the vicinity of the airport.

- **15 November 1997.** During takeoff from John Wayne Airport (CA) an Airbus 320 ingested a large bird into 1 engine, causing a fire. Passengers reported hearing a loud boom. The aircraft dropped momentarily before recovering altitude. The aircraft circled for 30 minutes before making an emergency landing. There were no injuries. The bird hit and broke several blades on the starboard fan. Pieces of the broken blades then broke or bent all blades, caused damage to the cowling and to system behind the fan. The engine was replaced.

- **9 January 1998.** While climbing through 6,000 feet, following takeoff from Houston Intercontinental Airport (TX), a Boeing-727 struck a flock of snow geese with 3-5 birds ingested into 1 engine. The engine lost all power and was destroyed. The radome was torn from the aircraft and the leading edges of both wings were damaged. The pitot tube for the first officer was torn off. Intense vibration was

experienced in the airframe and noise level in cockpit increased to the point that communication among crew members became difficult. An emergency was declared. The flight returned safely to Houston with major damage to the aircraft.

- **7 May 1998.** On climb out from Colorado Springs Metro Airport (CO), a Boeing-727 encountered at least 6 large white birds. The aircraft suffered an uncontained failure in #3 engine. All inlet guide vanes, all 1st and 2nd stage compressor blades, and 1st stage stator vanes were damaged. The birds punched a hole in the anti-ice bleed air duct and damaged a wiring harness. Intense vibration broke the oil cooler. The radome was cracked and a wing-tip had minor damage. The aircraft declared an emergency and returned safely to Colorado Springs Metro Airport. The aircraft was out of service for 98 hours.

- **15 August 1998.** A Jetstream-31 landing at Altoona-Blair County Airport (PA) hit a mixed flock of birds (22 doves and killdeer) during landing roll. One engine was shut down after ingesting birds. The engine was removed for overhaul.

- **22 February 1999.** A Boeing-757 departing Cincinnati/Northern Kentucky International Airport (KY) had to return and make emergency landing after hitting a large flock of starlings. Both engines and 1 wing received extensive damage. About 400 dead starlings were found on runway area.

- **3 March 1999.** A DC-9 cargo plane on short final into Kansas City International Airport (MO) at 2230 hours struck several snow geese. Geese were ingested into both engines. One engine was destroyed and the other lost 50% of power. The pilot was able to land the aircraft safely.

2.7 CONCLUSIONS

Wildlife strikes can cause serious damage to aircraft and the occasional loss of human life. Because most strikes occur on or near airports, airports are the logical places to put emphasis in addressing the problem. The following chapters and appendices, coupled with guidance from professional wildlife biologists trained in wildlife damage management, provide the information needed to develop, implement, and evaluate wildlife hazard management programs to minimize the likelihood of wildlife strikes at airports.

Wildlife are attracted to airports for food, water or shelter. The first step to reduce numbers of hazardous wildlife at airports is to determine the attractive factors. (Photo by E. A. LeBoeuf, USAF)

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